

Robotics systems 'sniff out' chemicals

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Photo credit **U.S. Army photo**

William Benard, clean room manager for the U.S. Army Research Laboratory, holds a microelectronic chip.

ADELPHI, Md. (Dec. 21, 2010) -- The U.S. Army Research Laboratory is leading research in robotic systems that can sniff out chemical agents.

ARL's robust research with the University of Michigan and University of Pennsylvania is developing a portable micro gas chromatograph as a system on a chip no larger than a dime.

The system, integrated onto a mobile robot capable of doing autonomous searches, acts like an electronic nose and is able to detect chemical agents and identify the threat.

Weapons and materials engineers, along with sensors and electronics experts, are creating technology that can do more than detect chemical signatures associated with explosives and chemical and biological weapons.

Researchers hope their research could become part of a system of small robots to locate people, explosives and chemical and biological weapons. It could also map a building or other structure like a cave and communicate back to Soldiers before they enter a potential fatal hazardous environment.

Army researchers say the technology is small enough to be integrated into Soldiers' uniforms or vehicles to advance the portable network of chemical and biological systems. It also has implications for early-warning systems to support homeland defense in subways, airlines and buses.

ARL's work is focused on the Orion, the next-generation system that builds on the gas chromatograph Mercury. The Mercury can provide the selectivity, sensitivity and rate of analysis at a small size,

weight and low power, enabling tactical deployment. Army scientists say integrating this capability into a mobile, autonomous platform has not been done before.

"Gas sensing systems with this degree of sensitivity and specificity have typically been large, stationary monitoring devices," said William D. Nothwang, material scientist and ARL lead for the Micro Autonomous Systems and Technology-Microelectronics Center. "The chemical bouquet that the Soldier is exposed to is exceptionally crowded, and many of these chemical scents are potentially dangerous, toxic, or hazardous.

"Having the ability to detect these chemicals at very minute concentration amid a crowded background enables a new level of sensory awareness," explained Nothwang.

The gas chromatograph takes a gas sample, separates it into constituent components and identifies the chemicals. The work is being directed as part of the University of Michigan's Microelectronics Center under ARL's Micro Autonomous Systems and Technology Collaborative Technology Agreement, which aims to perform enabling research and transition technology that will enhance the warfighters' tactical situational awareness in urban and complex terrain by enabling the autonomous operation of a collaborative ensemble of multifunctional, mobile microsystems.

The University of Michigan developed the Mercury under the National Science Foundation Wireless Integrated Microsystems Engineering Research Center from 2000 to 2010. ARL is lending its expertise to the University of Michigan in the follow-on technology project, Orion, which is focused on taking the sensing capabilities of Mercury and scaling it to significantly smaller devices and applying the technology to Army-relevant applications.

Earlier this year, the collaborative team began prototyping an integration of the Mercury with the Scarab, which is a fully autonomous robot about the size of the Roomba, the iRobot vacuum cleaner. It was designed and developed by the University of Pennsylvania for use as a research tool investigating autonomous behavior.

"The University of Michigan integrated the Mercury gas sensing system onto a Scarab platform, and the University of Pennsylvania designed a series of autonomous behaviors to enable it to enter a room to search for explosives, identify its agent characteristics and communicate back the exact location and nature of the agent," Nothwang said.

Nothwang said the Mercury and the Scarab are two incredibly complex systems.

"Individually there were a number of technological obstacles that were overcome," he said.

During the integration, challenges faced included the development of a common interface and communication protocols; designing an efficient search strategy based on the sensor input; developing a control language and analysis software that could be completely autonomous from user inputs; and designing realistic bounds on the behavior that would result from the sensor output.